Linking Leadership and Technical Execution in Unprecedented Systems-of-Systems Acquisitions

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The acquisition of systems is as much an art as a science, a premise that is underscored by the limited understanding of the variables found in complex systems-of-systems. Moreover, the art and science associated with acquiring systems has been steadily increasing in complexity as the various technologies being acquired have made huge advances in capabilities. One of the most challenging types of acquisition to execute well is that requiring the development of an unprecedented system-of-systems or an ultra large scale system. The challenges to the acquisition staff range the spectrum of those faced at all levels in the acquiring organization from that of the most senior leadership and management, through those architecting the system, down to the individual engineer executing technical tasks as a part of the concept, design, development, fielding, and sustainment of such systems-of-systems. Leadership theory based on transformational and transactional leadership styles assists in highlighting leadership problems in unprecedented acquisitions. Coupled to these challenges are the clearly demonstrable requirements for ever closer linkages between each of the discrete functional levels within the acquiring organization. The study of the essential nature of theses linkages, and how their performance can severely impact the probability of success and effectiveness of the acquisition, is examined through the evaluation of a number of exemplar case studies. Using analytical insight derived from these case studies, combined with the application of current theories on leadership and management, this paper evolves the transdisciplinary premise by articulating that leadership and technical execution must be tightly linked especially when developing unprecedented systems-of-systems.

***Keywords**: precedented, unprecedented, acquisition, system-of-systems, architecture, management, leadership, transactional, transformational, case study*

1. Introduction

Acquiring complex systems in the 21st Century incorporates both the art of executing an acquisition and the sciences necessary for dealing with complex system components. Throughout the acquisition of complex systems information represents the *life's blood* that must flow freely between and among all parts of the acquisition organization in order for there to be an overall successful outcome (Defense Acquisition Assessment Panel, 2006, Vandergriff, 2006, & Raduege, 2004).

This prevalence of *information networking technologies* have led to the desire to create operational systems that are tied tighter and tighter together within their enterprise until, ultimately, the enterprise itself must be viewed, managed, and even acquired as a system-of-systems. To meet the issues emanating from the variables associated with a specific acquisition, specific assumptions must be made in order to meet those outside variables.

In a broad, commercial, context many such systems-of-systems are acquired successfully. Examples of such successes include integrated electronic mail and calendar services, financial accounts receivable systems, and many others. The differentiating point is that these successful, complex systems-of-systems, by their very existence, are considered *precedented*. In other words, each such system addresses a similar functionality developed earlier using older, less complex, technologies.

The leadership and management in a *precedented* acquisition are better able to articulate a vision that is not only more easily understood, but also a vision that the technical people know how to solve *even if the solution is complex* (Luman & Scotti, 1996). The executing management is able to effectively measure the progress of the technical engineering staff, as the management has had experience in which metrics have been successful predictors of effective performance in the past. Based on such past experiences *precedented* systems are often acquired with little difficulties.

More challenging is when leadership envisions, and requires, the acquisition of an *unprecedented* system-of-systems. In this scenario, the *unprecedented* nature of the system can lead to the fact that the vision itself, as articulated within the system architecture, may not be easily understood as one goes down the execution lifecycle. Moreover, the technical engineering implementers may not know of any architecture that meets such a vision. The urge is for technical engineering personnel to simplify the problem to one they can solve. This propensity can lead to a divergence between the leadership vision and the ultimate technical solution.

Moreover, the intervening management is unlikely to be measuring all the right factors involved with the technical tasks, as the *unprecedented* nature of the system means that there are areas that have *not been done* before. At bottom, in this scenario there is no *guidebook* for which metrics to collect that might serve as predictors of effectiveness or what the values of those metrics should be. In such an environment, managers will likely revert to measuring the *unprecedented* project in a way that is predicated on how they have succeeded in the past; hence they will either miss collecting some pertinent metric, or insist on interpreting the metrics as if the project is similar to the one in the past. It is incumbent upon senior leadership to remain aware of such masking tendencies and, while being on the look out for indicators, they must also reinforce the original, *unprecedented vision.* Once again, the *unprecedented* nature of the system means such assumptions might not work.

A major question before us is how should an organization link between the leadership level, through the middle-management level, to the technical operations level so as to ensure that the vision and requirements are adequately articulated? This paper presents selected evidence of how this critical linkage is difficult to forge or broken in *unprecedented* systems-of-systems, and offers a leadership model to handle the unique challenges of this class of systems.

In order to describe this connection, the paper is divided into a number of Sections. Section 2 addresses essential background information about systems-of-systems and the clarity differentiating acquisition leadership and management. Section 3 discusses the acquisition leadership dynamics that will be considered while analyzing the case studies by outlining the principles of transactional verses transformation leadership, how the organizational structures can be described, and the nature of the dynamics between leadership and architecture. Section 4 provides three system-of-systems acquisition, development, and user verification case studies and discusses the analysis of the similarities and differences between those cases and their applicability in the evolution of the leadership model. Section 5 provides the initial thoughts pertaining to a new leadership model for application in *unprecedented* acquisitions. Section 6 summarizes conclusions drawn from this work and provides suggested directions for future research.

2. Background and General Overview

This paper views a system-of-systems within the context of transformation and net-centricity which are the current perspective being applied across the acquisition community in the United States Federal Government. In order for these terms to be harmonized to the authors' intent, appropriately clarifying definitions are provided.

What is a *System-of-Systems*?

In considering what constitutes a System-of-Systems (SoS), we first must ask and respond to the question concerning the difference between a *system* and a *SoS*. A straight forward definition is that a *system* is *a group of elements that interact and function together as a whole* (Webster's , 1996). Based on this definition, a SoS would be one in which a group of systems, rather than the part-elements, interact and function together as a whole. This has led to the creation of a series of differentiating characteristics for systems (Boardman & Sauser, 2007); *autonomy of component systems, belonging/ownership*, *connectivity*, *diversity management*, and *nature of emergent behavior handling*. Although these characteristics do not give us a strict definition for a SoS, we can use these characteristics to help us discriminate between a *system* and a *SoS*.

For example, component-elements in a system are subordinate to the system; however in a SoS, *autonomy* is exhibited *by the component-systems*.

In another example, the *belonging/ownership* characteristic of a system indicates that systems tend to be made of components that belong to that single system; whereas in a SoS, the overall system does not own component-systems, and indeed the ability to do the system's mission is wholly dependent on the component-systems *desire* to provide their functions. For our purposes, we will consider SoS examples across the spectrum of characteristics; however, the essential aspect is that the component-systems of a SoS must have independent, useful functions within and outside the SoS and each component-system must be managed and maintained for its own purpose. Such a stricture heightens the complexity associated when such systems are brought together. Well known examples of such complex integrations are the many e-mail, contact, and calendar applications; stand alone and distinct sub-applications that have been melded into SoS.

A counter-example is when multiple independent acquiring agencies come together to build a system; if each agency brings specially crafted components, not systems that are functional outside the new system being developed, then that system is not considered a SoS. Therefore, only when *independent* systems are brought together does the true nature of the complexity of a SoS become apparent. Often, when a single acquiring organization is acquiring multiple systems, by using a single acquisition structure system complexities can be heightened since many component systems tend to be operationally and managerially independent. This distinction is important in order to fully comprehend how acquisition leadership and architecture engineering can often be separate and distinct. Moreover, the acquiring senior leadership is burdened for in addition to having to understand the intricacies of the systems to be acquired, along with the complexities of their own acquiring organization, in order to grasp the true magnitude of the complexity of a SoS, the senior leadership must also look at the entirety of the SoS *lifecycle;* development, implementation, and verification at the user level.

What differentiates SoS *leadership* and *architecture* engineering?

Discussion on the architectural effort needed for a SoS is presented by Luman & Scotti, (1996). However, this paper focuses on the work performed during the execution of an acquisition program that will integrate systems into a larger SoS. The roles of the acquisition organization personnel, leaders, managers, and architects, are normally undefined for the SoS. Rather, in a *net-centric* manner, large organization effort is placed on enabling systems in acquisitions to be SoS *ready*. It is not within the scope of this paper to detail what aspects make up *net-centricity* nor the distinct differences between systems *interoperability* and *integration* at the different program levels. Yet, there are a growing number of acquisition programs that lay claim to having met the rigors necessary for the executability of *net-centricity*. It is important to note that success in the development phase of an acquisition lifecycle does not necessarily connote success of the SoS throughout its entire lifecycle as is found in the case studies below.

In SoS, typically, methods such as *open architectures*, realized through multiple numbers of technologies, such as *service-oriented architectures*, are the principal ways traditional system acquisitions defend their SoS position (Luman & Scotti, 1996). However, for each actual SoS, typically there is no single program manager who has authority over the whole set of component-systems.

Leadership and architecture engineering within SoS remain differentiated at the role and responsibility levels (Homrig, 2001). In normal circumstances, architecture engineering takes place early in the design phase of the program where influences that will remain in place for many months or years in an acquisition, will be posited during this early effort. While the architecture that has been decided upon may be modified over time, the principal themes and goals normally remain intact. In a sense, we can view such an arena as being generally stable and predictable even though such architectural engineering may be dealing with an *unprecedented* SoS.

The corollary, however, frequently does not hold for the roles and responsibilities of the acquisition leadership. The leadership roles and responsibilities expand well beyond the boundaries of any one discipline and require that the incumbent leader not only be cognizant of the many disciplines involved in the SoS acquisition, but also that the leader views the multitude of components, including the people assigned to the acquiring organization, in the SoS from a *systemic* point-of-view. Hence, there is an early hint that acquisition of *unprecedented* SoS calls for a different, more holistic, point-of-view on the part of the senior leadership. The leadership and architecture engineering in the acquisition of unprecedented SoS find themselves viewing the acquisition differently based on the roles being performed in the program.

What differentiates between an *unprecedented* verses *precedented* system?

Finally, we need to consider what *precedented* means with respect to the architecture of a system or a SoS. *Precedented* systems, simply put, are those that have been built before. This does not mean that the exact system in the exact configuration must be built multiple times, since that would mean that only manufacturing in quantity would represent a *precedented* system. We are considering a spectrum of characteristics for evaluating whether a system is *precedented*: *functional capability*, *internal/logical organization of components*, and *relationships to external stakeholders and systems*. Considering these characteristics broadly, the final characteristic is the most unique, and generally most descriptive of the *precedented* nature of a system especially for a SoS.

For each of these characteristics, the architect must understand if prior examples of systems, or a SoS, can be applied in this context and thus inform the engineers about how to design and build the system. If, for example, new data interfaces are going to be introduced to new users who have never had access to the data before, then those interfaces are *unprecedented*; designers and engineers will not have prior examples on which to base development. Also, consider if an agency is moving from using human judgment to automated analysis, as will be seen in a case study below in a larger SoS; in this case the system being acquired may be *unprecedented*, in that its requirements are more specific *than those that do what the person currently does,* and may take several iterations of operational systems before requirements will accurately reflect what the system requires.

3. Acquisition Leadership Dynamics

3.1 Leadership and Management

Regardless the human endeavor, leadership has been a common thread that has run throughout. For most of recorded history, leadership has been relegated to the study of *traits* that an individual leader exhibits or whether the individual leader can be perceived to be a *great man* affecting his time. With this history, leaders were normally measured by the *traits* they exhibited that had been found to represent the best *traits* of great leaders.

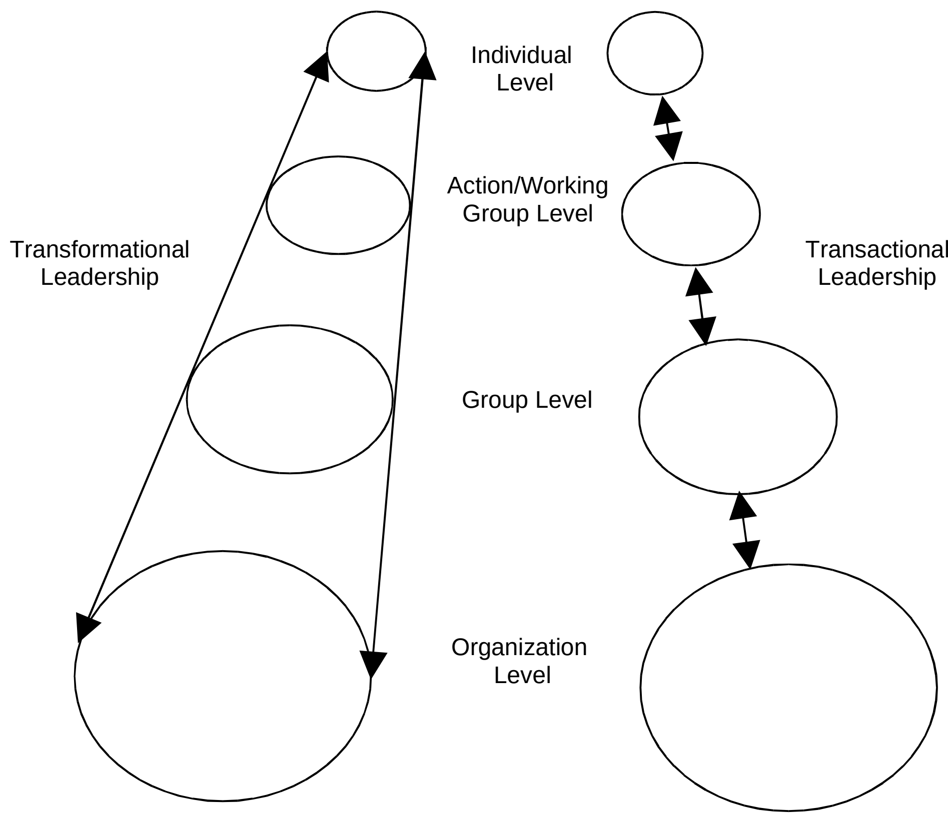
Beginning with Taylorism (Wren, 1994), the *very best men* were sought out as representative not of leaders but of the best man for a job. In order to elicit the very best from such *best men*, supervisors were called upon to better supervise or *manage* the workers who they supervised. Hence, the evolution of management tools came into vogue and began to take on the rhythm of a science with appropriate metrics and improvement movements. By this juncture, the concepts of *leadership* and *management* diverged.

This approach remained the principal focus in management training throughout most of the last century. Extensive tool-sets have been applied in order to better manage human endeavors, like acquisitions, while the theoretical premise for leadership has languished. Toward the late decades of the 1980's and 1990's, it began to be realized that the focus on *managers doing things right* necessitated a set of talents that required leadership. This focus led to the understanding that effective *leaders did the right thing* (Bennis, 1987). As stated by Kuhn (1996), science changes *paradigms* as older theories are found to no longer be sufficient to explain the dynamics associated with changes in impacting environments. What has led innovative thinkers, in the field of leadership study, to newer premises is that, fundamentally, leaders and managers, while ultimately striving for the same long term goals, will utilize different approaches for arrival.

Similarly, a large body of work in organizational leadership theory was begun based on the seminal work by J. M. Burns (Burns, 2003 & 1978), and has been focused on the identifiable difference between performing work using a *transactional leadership style* as opposed to performing work using a *transformational leadership style.* The difference may seem, at the surface, to be moot because both are valid *leadership styles* and would be applied solely on the whim of whether the individual leader felt more comfortable with one style or the other. However, such has been proven not to be the case (Hay, 2007, Bass, Avolio, Jung, & Berson, 2003, Homrig, 2001, & Bass, 1999 & 1990).

What has been identified in the research to date has been that using the *transactional leadership style* is greatly dependent on *static, understood,* and *predictable* situations which are closely related to the definition of a *precedented* SoS acquisition. On the other hand, using a *transformational leadership style* is greatly predicated on the situation being *unstable, fraught with uncertainty,* and *unpredictable.* These same variables are found in the description of an *unprecedented* SoS acquisition.

To better describe the difference between the two leadership styles, the fundamental *linkage flows* are shown in Figure 1, below.



[1] Adapted from Bass, B. M., Avolio, B. J., Jung, D. I., & Berson, Y. (2003). Predicting unit performance by assessing transformational and transactional leadership. *Journal of Applied Psychology, 88*(2), 207-218.

Figure 1 – The Differentiation between Transformational and Transactional Leadership Styles

Take-away points include the fact that in applying a *transactional leadership style,* as on the right side of the diagram, discrete transactions occur as the leader requires a particular action to be performed by someone or some subordinate organization where there is the expectation of some measure of discrete reward being supported upon completion of the task, hence the basis of a *transaction*. The *transactional* approach is closely linked to the management of discrete tasks, requiring little in the way of visioning or attention to the individuals being tasked. Moreover, each task can be managed separately without necessarily taking other variables into account.

In the case on the left, depicting the more *systemic* perspective ascribed to the *transformational leadership style,* the leader makes a conscious effort to include in his or her consideration all applicable variables associated with the task or task-set that is under consideration and the broader programmatic impact from variables that are not linked to specific tasks. This approach would be held to be *systemic* in nature. In keeping such a *systemic* perspective in mind, the leader in question ensures that fewer unknowns can impact on the discrete tasks or on the acquisition as a whole. Not that the *unknowns* will not occur but that they will, in fact, be viewed as *knowns.*

Moreover, as Bass and Avolio worked to *operationalize* Burns' theory, they developed the Multifactor Leadership Questionnaire© that provided a mechanism for ascertaining specific components that make up the *transformational* and *transactional* leadership styles (Avolio & Bass, 2006 & 1999 and Lowe & Kroeck, 1996), and how they would impact the effectiveness of an organization in the pursuit of the organizational goals (Bass & Avolio, 1994).

As a starting point, in Table 1, is listed a few of the benefits and barriers associated with using one leadership style over another.

Transformational	Transactional
Builds subordinate capabilities & potential through experiences	Maintains subordinate levels & grows individual experience
Builds trust, understanding, & morale	Focuses on "wait for direction" work ethic
Encourages multi-linear capability focusing on maintaining or reducing schedules	Encourages linear actions focusing on extending planned schedules
Enables innovative approaches to reach solution	Has neutral impact on applying basic solutions
Enables perception of value to overall mission success and effectiveness	Limits perception of value to overall mission success and effectiveness
Provides capacity for transfer of knowledge	Provides individual with narrow experience profile
Requires trust	Does not encourage trust
Requires appropriate training	Does not require much training to maintain competency

Table 1 – Benefits and Barriers Ascribed to Transformational and Transactional Leadership Styles

There is not a *valuation* associated between the two *leadership styles.* It is noted that there is not an *all or nothing* scenario ascribed to either leadership style. In attempting to be effective, a leader who has attained an understanding of the two styles will judiciously apply the style in the context of the situation (Eid, Johnsen, Brun, & Laberg, 2004). What does demonstrate a differential between the two styles is when a leader has not been apprised of the power of using a *transformational leadership style*, and subsequently he or she might not have had the opportunity to study or hone that capability.

3.2 Organizational Structure Affecting Success

When organizations are studied for their efficacy (Scott, 2003), the underlying message that is taken away is that no one organizational structure fits all situations or is best suited for the attainment of all goal-sets. Acquisition organizations, however, tend to be principally structured hierarchically. In all hierarchical acquisition organization there exist a dynamic between *leadership*, *management*, and the *technical engineers* who execute the acquisition programs. The mental model described below addresses this dynamic.

In the authors' extensive study of the structural connections between *leadership*, *management*, and *technical engineers* and those addressing the connection between the leader and the led, it was found that as research has expanded the knowledge base in the discipline of leadership, more and more frequently the various leadership concepts can only be articulated using ever-more complex mental models of the combined dynamics. Initial leadership models were derived from psychologically-based personality behavior and trait research. However, those models did not suffice yet have created extensive leader behavior categorizations that confuse leaders as to how to execute their roles and responsibilities. Based on the myriad of check lists and strictures posited by the counseling hosts, the individuals who were charged to fulfill leadership roles remain unsure as to what their relationships with their workforce are and how the associated dynamics should play out to attain success.

After many years of research and discussion, the realization came into sharp relief that perhaps more complex models of leadership were satisfactory from a research stand point but such complexities were masking the important messages about the dynamics between *leadership*, *management*, and *technical engineering execution* and, therefore, were not accomplishing the desired goal; the extension of leadership understanding and application.

The context of the dynamics of *leadership – followership* (Hock, 1999), naturally drives toward a position where senior leadership needs to be, or at least needs to seem to be, in balance with middle management and both are, or must seem to be, in balance with the technical engineers who must execute the acquisition (Sisti, 2007). Before describing this mental model of leadership a couple of critical definitions should be put in place.

Balance – Rather than use the term *homeostasis*, the word *balance* was chosen to represent the dynamic component in the formula. This is not balance in the sense of counter-balancing as in a two-armed scale but rather balance in the context of one component in the formula not over-burdening another component as they exist in an organization's hierarchy.

Senior Leadership – The organization senior leaders are the visionary component of the organization and are responsible for pushing the envelope of action in an organization. It is their role to continually seek movement.

Middle-Management – The organization's middle-management constitutes the component of the organization that has the ability to extend themselves in order to react to modifications in the organization that are brought about by outside environmental forces or at the directional movement of the senior leaders of the organization.

Technical Engineers – The organization's technical execution engineers are rooted in their place by assignment or contract with very little flexibility. They look to their management and senior leadership to provide the necessary guidance and protection.

Linkages – The three components described above have discrete roles and responsibilities within the acquisition organization the success of which is predicated on the linkages between each of the components singly and severally. It rests upon the strength of these linkages as to whether the information flow that traverses the linkages represent a benefit or a barrier to the ultimate success of the organization and the acquisition.

With a grateful nod toward the principal of parsimony, Occam's razor (Audi, 1995), as the premise for a graphical representation of this model it began to take on a driving form with the goal to ensure that the mental model was as straight-forward as possible while still identifying the dynamics involved.

Using a *word-description,* the model is graphically represented by envisioning an individual's arm from the elbow to the tips of the fingers, held in a vertical position, with the hand at the top representing the organization *senior leadership*, the forearm representing the organization *middle-management*, and the elbow representing the organization's executing *technical engineers*. In the vertical position, it is easy to envision that if any of the three component segments are out of alignment, or *linkage,* with one another, the organization is out of *balance* and hence, the effectiveness of each component in the accomplishment their respective roles become dysfunctional and often contra-productive. More importantly, the organization is placed in jeopardy of failure. The normal dynamics of the individual organizational components create a constant tension between them because of the content of their respective roles.

Senior leadership is responsible for and expected to take the organization into innovative situations thereby generating risk of failure in the organization but also the potential for advanced opportunities. At the other end of the organization spectrum, the *executing engineers* are bounded by the constraints put in place by the organization as they apply to a specific acquisition.

It is the organization role of the intervening *middle-managers* that is in most jeopardy in this environmental tension. As *senior leadership* moves further away from the contractual boundaries of the *executing engineers*, it is the *middle-managers* who are expected to act as the buffer in dealing with the tensions created. Unfortunately, it is normally the *middle-manager* who has not been adequately prepared to deal with such tensions and therefore, the organization is once again in jeopardy of failure.

It is a solution for this discontinuity that calls for a transdisciplinary approach to applying successful leadership in an acquisition organization, especially when pursuing the acquisition of a SoS.

3.3 Leadership-Architecture Dynamic

In the dynamic between leadership and architecture, we need to understand what an architecture is and who generates architectures in normal systems. Then we can examine issues in how the relationship between leadership and architects impact the system or SoS being acquired.

Architectures are defined by various fashion, but one definition brings together many of the common aspects: “Architecture: ... (4) The organizational structure of a system or a software item, identifying its components, their interfaces, and a concept of execution among them.” (IEEE, 2007). For a SoS, its architecture would consist of systems in addition to components, as not every element of a SoS must be a system. Although this definition tells, us what the architecture is, it does not put that architecture into the appropriate context. For that, we need the architect.

System architects, for our purposes, are the people who develop applicable system architectures. For most systems, this is a function assigned to the system engineering team and delegated to an individual or sub-team, as explained in the INCOSE Systems Engineering Handbook (INCOSE, 2006). Examining the architecture in this way, we differentiate the technical activity of achieving a consistent logical architecture that meets requirements from the requirements development activity that would drive the creation of an architecture. These system architects establish the common technical vision for the teams of engineers that will design, produce, test, and deliver the desired system. Minor divergences between the view of these architects, managers, and senior leadership can lead to a technical system that is out of alignment with organizational goals.

To accomplish their goal of articulating a technical vision, yet not overly constraining designers and developers, architects use a variety of methods, two examples are *abstraction* and *simplification* (INCOSE, 2006). In attempting to simplify the system, architects must balance the desire to model the system in such a way that it appears as simple as possible, but no simpler. An overly complex model may be meaningless to managers and senior leaders, while an overly simple model may enable engineers to build a system that is not useful. In a similar way, abstraction is accomplished through modeling. If the architect chooses models that are not appropriate to the problem domain, then regardless of the abstraction's ease of understanding, the model may not communicate essential information about the system under design. At bottom, these abstractions and models help leaders and managers know what details can be "left in the design space". However, there is a danger.

Box observed that "all models are wrong, but some are useful" (Box, 1979). The architect must utilize this fact in a delicate balancing act. In one way, choosing models that managers may already know will help determine which details are unimportant to the given level of discussion, and thus can be left to the designers and developers. However, when the architect is working with an *unprecedented* system, or a system in an *unprecedented context*, models from previous experience may abstract away details that, while previously unimportant, are now essential to the success of this unprecedented system.

For a SoS, Box's statement is even more confounding. Constituent systems may have architectures that provide insight that was appropriate during their individual developments. When composed with a number of other systems, a quality that is un-modeled in any of the systems may become essential for the SoS to achieve its goals. In this way, the models and architectures selected for the component systems may not truly inform what needs to be modeled at the SoS architecture level.

Thus, architecting an *unprecedented* SoS is a difficult activity for the architect. The architect must figure out what methods to employ, with the understanding that the previous experience and currently utilized models may be inadequate for expressing the scope of the system to the various stakeholders. Over reliance on a priori models may result in the utilization of models that do not appropriately reflect the reality of the system, or worse, force design decisions that can cripple the needed system. In a similar fashion, leaders and managers of architects must work with the fact that because the SoS is *unprecedented*, that they must both shape themselves and the architects to do what is necessary to deliver a successful system.

Finally, acquisition technical architectures provide the mechanism between which technical and non-technical programmatic elements harmonize the acquisition environment. Elements such as budgets, contractual vehicles, multiple requirements communities, and multiple user communities must be served by the leadership and management of the acquisition. Many of these elements may have questions requiring technical analysis. Depending on the phase of the program lifecycle, the technical execution may be within the program office (during concept definition), with the prime contractor (during system design and production) or in the operating organization (while the system is operational). Thus the architects must consider all the issues raised in developing a SoS architecture to serve all these stakeholders.

4. Observed Case Studies of System-of-Systems technical (architectural) interaction

The following three different cases were selected because they are representative of the three aspects of the acquisition lifecycle of a SoS mentioned earlier; development of an unprecedented technology, the operationalization of a SoS, and the verification that the developed SoS meets the user's needs. The three selected cases are briefly presented below as offering insight into the linkages identified earlier in the mental model and the impact of such linkages. The selected case studies also illustrate where a technical solution was successfully produced, but due to mis-alignments from the leadership through the management to the SoS architects, the systems ultimately were not successful either from the leadership or user/customer viewpoints.

4.1 MP3.COM – *unprecedented technical success/management failure*

This organization represents the operationalization of a European-designed MPEG-1 Audio Layer 3 (MP3), audio-specific compression algorithm that was marketed by Michael Robertson beginning in the early 1990's. In bringing the technology to market on the internet, Robertson tapped into a desired direct connection between the music consumer and the music artists who agreed to use this site as the distribution network for their copyrighted works. The immediate success of MP3.COM was indicative of the frustration that existed in the consumer base where they are normally forced to purchase an entire album from outlets of one of the major music companies even if the consumer really only was interested in one music track on such an album.

While this innovative approach appealed to thousands of music consumers, the natural limitations of the numbers of music artists who had signed up for MP3.COM's distribution services demonstrated that the company had to extend the original innovative approach to a broader base of available music. This led to the development of the MY.MP3.COM service. In order to meet the goals of this new service, MP3.COM had to literally have the rights to every track of music that had ever been created. In creating the server-based music library, MP3.COM did not necessarily gain such rights. It was at this juncture when a series of law suits were brought against the company. Many of these were settled outside of the court but in one case, the suit went to trial which ultimately led to a negative judgment of up to $53.4 million against MP3.COM for copyright infringement.

Mr. Robertson eventually sold the company to Vivendi, Inc. which in-turn sold it to CNET NETWORKS which now operates the company without the music library.

4.2 Surface Assessment Robot (Integrated Construction Management) – *use of a precedented technical solution in unprecedented operational environment/management failure*

The case of the surface assessment robot (Latimer, 2007) outlines a technical triumph, but an overall acquisition failure. This robotic system was intended to replace the manual inspection process that assesses the smoothness of a roadway to be used by automatic vehicles with standing passengers. Overall, the system delivered a 100-to-1 return on investment (realized through greater than 100-to-1 savings on operations effort for the inspection), which included funding its research and development in the first operational evaluation. However, ultimately several factors regarding how the acquirer viewed potential architectures led to an over-constrained situation that prevented the development of an operationally suitable system.

To the acquirer, the requirements essentially were to “do the inspection like our best expert”. The development team had access to the expert over many technical meetings, field observations, and personal interviews. Also, the development team became familiar with all the various contractual obligations, requirements from the licensed civil engineer who oversaw the roadway construction, and organizational requirements, which included requirements for collecting and reporting process deviation information to a quality assurance and process improvement office.

The issue rapidly came to a point in a difference between the designers at the developer and the acquirer's engineers about how best to use profile data to identify road smoothness deviations. After the principal road profile sensor was selected, the developers wanted to simulate traffic over the sensed profile, to determine if the ride quality of that profile is sufficient. However, the acquirer wanted to treat the profile like the human and only identify when absolute deviations occurred in the profile (essentially when the amplitude of the roll of the road exceeds a certain threshold over a given length). The acquirers insisted that their method was how the field inspectors operated, and that method must be how the new robot interprets the data.

At the same time this is occurring, the acquiring company was being bought by a new parent company. In this new parent company, innovation was to be performed “off-the-shelf”. The new parent company did not believe in sponsoring custom developments, preferring instead to utilize systems that would have long-term support from a vendor. Since the corporate resources for the project had been committed, the project was allowed to continue, with the understanding that the acquirers and developers would only have one operational assessment opportunity to demonstrate their system. This environment prevented any form of competition between the ideas of the acquirers and developers. In this case, the acquirers prevailed in directing that their method of interpreting the data would be utilized. Although the topology of the architectures between the acquirers and the developers was the same, the nature of one of the boxes, and thus the exact information that would be relayed to the whole enterprise, was fundamentally different between the two.

When the system was finally brought out to the field for operational assessment on a freshly constructed road, the system marked two orders of magnitude more deviations than anticipated. Initially believed to be false positives, on manual inspection, all the deviations were validated. This came as a surprise to acquirer and developer alike. The developers had access to sample roadways. However the roadways had been used for testing by the acquirer for years, resulting in a smoothing out of the very minor deviations. Further, the inspector indicated that most (99%) of the deviations were so minor that he would not have reported them. This fact had not been observed during the field observations, nor in any interviews. Due to this fact, and some additional concerns about the operations mode of the robot which as a sensing system required calibration, the system was not utilized beyond the operational assessment.

4.3 Force Transformation – A Network-Centric Operations Case Study: US/UK Coalition Combat Operations during Operation Iraqi Freedom – ***unprecedented technical success/leadership & management failure***

The Department of Defense Office of Force Transformation conducted the subject Network-Centric Case Study in 2003 to assess United States Forces and United Kingdom coalition combat operations using the Network Centric Operations Conceptual framework as the basis for analysis. The common development product on which the study was focused was the utilization and efficacy of the Force XXI Battle Command Brigade and Below (FBCB2) Blue Force Tracker (BFT), or the FBCB2/BFT System as it is commonly known, as the demonstration (Office of Force Transformation, 2005). This was to be a comparative study with the researchers positing that each set of coalition units use as a baseline the situational awareness data provided by whatever mechanisms and equipments that the units had used in the past, prior to the receipt and training on the FBCB2/BFT equipment. Moreover, the FBCB2/BFT concept represents a SoS based on the facts that the FBCB2/BFT equipment are made up of a Global Positioning System mounted on unit vehicles, using satellite communications extensively to move massive amounts of friendly unit data around the battle zone in a secure manner, and in a relatively short period of time making coalition ground commander decision-making as real-time based as possible.

While the original intent of the study was designed to ascertain the improved situational awareness provided through use of the FBCB2/BFT SoS, between coalition forces, it was found that there were limitations in place because of the difference in the numbers of FBCB2/BFT systems that were deployed in the combat units of the selected United States Forces and those of the United Kingdom. In short, this limitation meant that the researchers had far fewer available users to interview in the United Kingdom Units than the number that were using the equipment in the United States Forces. An original, extensive, interview plan that had been developed was modified when the research team was in country based on the lower density of actual system users that were found within the United Kingdom forces.

Even with the limitations presented by the density of FBCB2/BFT equipment, the study was conducted and the available data was analyzed. The reported analysis reflects the lowered density of equipment and hence, limited coalition conclusions were drawn. The researchers were able, however, to provide additional clarity concerning the situational awareness and the dissemination of that information among impacted units thus verifying earlier development conclusions. It was noted that the lower density of FBCB2/BFT equipments found in the United Kingdom Units had been based solely on decisions made by their Unit Command and Control hierarchy.

4.4. Analysis

In the case of the Surface Assessment Robot we observe a situation where the leadership of the sponsoring company desired a transformation of their business.

However, when execution began, leaders and managers lacked the ability to change themselves, to adapt themselves and their guidance, to bring this *precedented* technology to their enterprise in an *unprecedented* fashion to achieve their goals. In many ways, the leaders and managers desired a Commercial-Of-The-Shelf-like solution that could be plugged into their organization with minimal perturbation of people's view of their jobs. The inability of the leadership and management to operate an in *transformational* fashion led to a prescriptive requirements environment where, although the developers conceived of *transformational* solutions, the required trust was not present to enable leaders and managers to accept those solutions.

In this case, the system developers were able to get linkages established between the various entities that were going to be impacted by the new surface assessment robot. Through a significant number of stakeholder meetings, stakeholders were kept well informed about how the robot was being designed and would operate to meet their individual goals. However, the architecture effort, while significant, was only successful in guiding the downstream design and development activities, and had no success working to change the operational environment or get transformational involvement from the customer stakeholders. Thus, due to the transactional approach, a set of requirements were established that had no valid design space. This meant that no system could be designed that could meet the requirements, due to inherent conflicts within the requirements. Of course, there was no way to objectively demonstrate that this was the case, because no models existed for the architects to show that these requirements wouldn't work. Essentially, due to the unprecedented operational concept, designers, architects, managers, and leaders did not know their expression of the system requirements was unachievable. Ultimately this was demonstrated when the robot was deployed for its operational assessment, and while the customer validated that the robot met its requirements, including business case requirements, those requirements did not lead to a robot that would satisfy their desires. Thus, the robot remains unused to this day.

In the case of the MP3.COM, we see the operationalization of a *precedented technology* in an *unprecedented approach using the internet*. With the creation of the company, the older technology was connected to the internet in a manner in which the most efficient methodology for presenting commercial music selections to a demanding consumer public led to a SoS that effectively removed the middleman represented by the large music distribution companies and their wholly controlled music outlet retail chains. In retrospect, this operationalization was extremely effective and initially the largest problem that MP3.COM faced was a matter of being able to scale up to meet the huge demand that resulted.

Initial success, however, called for a well thought out strategy for avoiding entangling law suits based on copyright infringement. What the senior leadership of MP3.COM never grasped was that they had to deal with more than the consuming public. Theirs was wholly a transactional leadership environment based solely on the service provided the paying consumer hence creating no linkages that would assist in protecting the organization when the competition regrouped and used the copyright law against

MP3.COM. The senior leadership needed to have used a *transformational* focus since the environment was so unstable and they needed to have prepared and structured themselves to protect their success from the larger music chains that were losing revenue and control. Neither of these approaches was adequately applied. The necessary linkages had been ignored creating a deadly void. The mechanism that was used against MP3.COM was to focus on this void with a flurry of copyright lawsuits. Eventually, MP3.COM was unable to satisfy the judgments and the company was sold out from under the originators.

In the case of the Network-Centric Operations Case, the study itself was based on the *unprecedented SoS of the FBCB2/BFT concept* and was originally designed to reflect the impact of situational awareness data within and across coalition forces. That objective was not obtained. The research effort was ultimately considered a success, as is of course the FBCB2/BFT equipment. However, the research results provide insight into significant application deficiencies that can only be attributed to leadership failures.

Although this was a study of coalition situational awareness connections using the FBCB2/BFT, there had not been adequate architectural engineering applied earlier in the equipment roll-out so the density issue was bound to cause problems later on. Those problems surfaced during this verification research. What is of note was that the decision to use a lower density of the FBCB2/BFT equipments was dictated by, and internal to, the United Kingdom units themselves. This decision had a direct, negative, impact on the ability of the highly successful FBCB2/BFT equipment to raise the overall situational awareness between the coalition forces. Additionally, the capabilities of the concept that make this a SoS were limited to the extent where the conceptualization of the original SoS came under question. In short, the linkages between the senior leadership of the United Kingdom units and their field users were of insufficient robustness to have resulted in the equipment system being adequately acquired, stressed, and measured.

That this disconnect was observed during a neutral research effort provides a well documented lessons learned, not necessarily on the effectiveness of the FBCB2/BFT concept and equipments but, rather, on the extent to which coalition forces need to have equal capabilities provided from appropriate sources if the original goal structure and mission success were to be obtained.

In Table 2, the three cases are arrayed so that the reader can see how the authors rated the variables under consideration. Since the three cases represent different phases in a SoS lifecycle no comparison between cases is intended. What is intended is to point out to the reader that major disconnects exist in the critical execution of leadership issues in each of the selected cases. Additionally, it should be noted that each of the cases had a component that resulted in a categorization of being successful.

In the Surface Assessment Robot Case, accomplishing the technology development was certainly a success. In the case of the MP3.COM SoS, the initial consumer set certainly viewed it's establishment as a huge success over the earlier total control over the music industry by a few very large companies. However, the linkages failed to materialize that would retain the early success and ultimately, the MP3.COM failed and is still operating but as a shadow of its original self and promise. In the Network-Centric Operations Case, the SoS components that were focused on United States Forces, have been a resounding success, yet when extended to the critical coalition United Kingdom forces the entire purpose for existence eluded the coalition connection.

Variable/ SoS Case	MP3.COM Start-Up	SA Robot Development	FBCB2/BFT Study	Comment
Organization Structure (Transactional in Nature)	Large	Large	Large	
Organization Structure (Transformational in Nature)	Small	Small	Small	
Architecture Engineering	Small	Medium	Medium	
Linkages Established	Small	Medium	Small	
Decision Agents Being Well Informed	Medium	Large	Large	
Technical Expertise	Large	Large	Large	

Legend - Level of Effort : Small, Medium, & Large

Table 2 – SoS Case Studies by Variables

5. Initial Thoughts on a Leadership Model for Acquiring Unprecedented SoS

While performing their acquisition work roles over the past decade, the authors have been surprised and dismayed to find that there has been no effort devoted to casting light on the connecting dynamics described above in acquisitions of both *precedented* and *unprecedented* systems, other than the reliance of attempting to *refine management techniques*. Additionally, issues associated with rising complexity across and among systems being acquired, pose a growing dilemma as to whether current management techniques will ever be robust enough to handle organizations in the future that are going to be called upon to deal with this change in acquisition *paradigms.*

As the bulk of the affected acquisition community continues to refine management techniques in the *hope* that at some point they will attain that place of *balance* where acquisitions respond positively to the simple application of these refined management mechanisms, it becomes more and more evident that this *hope* is not a success-oriented approach to the growing situation. Two issues obtain; there is virtually no clear understanding of the differences between the distinctly roles and responsibilities of the senior leader, middle manager, and technical engineer, and there is only a limited understanding of the impact that *transformational* and *transactional* leadership styles have on the *effectiveness* of an acquiring organization and the overall acquisition. This paper is designed to begin filling this compound gap in our ability to acquire *unprecedented* SoS.

The necessary leadership model under development will have to meet a number of specific, and orthogonal, criteria in order for it to become successful; (1) it must be as simple as possible but no simpler, (2) it must be representative of a *living system,* a concept extensively articulated in Miller (1978), (3) it must include a point-of-view that encompasses all of the variables that impact the *unprecedented* SoS in question, (4) it must be robust enough to incorporate the *linkage dynamics* associated with the acquiring organization's hierarchical structure in order to ensure *acquisition success* across the whole *lifecycle* including *development, operationalization,* and *user verification,* and (5) it must be encompassing in scope so that the theory/model can easily adapt to the type of the SoS; and therefore, the leadership approach is agnostic as to SoS type, condition, or situation. In short, the proposed leadership model must be a *Systemic Leadership Theory/Model.* For such a theory/model to be developed it must be predicated upon a *transdisciplinary* base. This paper lays the groundwork for such a step in the first decade of the 21st century acquisition environment.

6. Conclusions

The paper has identified the fundamental flaws to be found in today's *acquisition* leadership and management approaches to *SoS* acquisitions. Where acquisitions have been focused on *precedented systems* success has been attainable in the past but as growing complexity and requirements force more *unprecedented* acquisitions to be attempted, past points-of-view no longer obtain. Success becomes less and less attainable without unlimited resources and time being factored into the initial plan. Since that perspective is inappropriate, a fresh look has to be taken at the variables that exist in today's acquisitions.

In order to establish a common frame of reference, specific terms call for clarification and broad understanding. Whether the acquisition is acquiring a *system* or a *system-of-systems* becomes an important differentiator as does the understanding of whether the acquisition is *precedented* or *unprecedented.* Moreover, success-oriented acquisition organizations require that a clear understanding exists relating to the respective roles and responsibilities of the acquisition *senior leadership, middle-management,* and *technical engineers.* To fully understand how those roles and responsibilities will be identified and applied, the acquiring organization must understand the difference between *leadership* and *management* and between *transactional* and *transformational* leadership styles. Without these common understandings, all attempts at establishing architecture, organization, tools, techniques, and legal boundaries suffer.

The authors have engaged the laying out of the problem and begun the evolution of an answering theoretical approach and model in a *Systemic Leadership Theory/Model*.

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